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A Study to Develop Expectancy Tables and Correlations for Prediction of Grades in English, Algebra, and General Mathematics from Selected Subtests of the Differential Aptitude Test

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A STUDY TO DEVELOP EXPECTANCY TABLES AND CORRELATIONS

FOR PREDICTION OF GRADES IN

ENGLISH, ALGEBRA AND GENERAL MATHEMATICS

FROM SELECTED SUBTESTS OF THE

DIFFERENTIAL APTITUDE TEST

being

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of the Fort Hays Kansas State College in

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by

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M. B. S.

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CHAPTER I

INTRODUCTION

I. Need for Study

A testing program is considered one of the important tools of counseling. Although test results should never be used as the only evidence of intellectual ability and aptitude of the student, they do play an important part in the evaluation of the student in the counseling experience.

What important information does the test score give the counselor and counselee? Do the test scores tell what can be expected from a student in the future? Test results are frequently interpreted to the student in percentiles which enable him to understand how he ranks in relationship to the standardization cases or if local norms exist, to the school population of the same age and sex. It is also possible to interpret test results through the use of prediction or expectancy tables.

The expectancy table indicates how likely the student is to attain any particular grade average. "It is a method which translates test scores into "chances of success" statements."[1] The expectancy table is constructed on the assumption that the best guess that can be made as to a student's

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[1]George K. Bennett, Harold G. Seashore, and Alexander G. Wesman, Differential Aptitude Tests Manual (Third Edition, New York: The Psychological Corporation, 1959), p. 62.

probable success is what students with similar scores have done before him.[2] "The expectancy table has the advantage of making easily apparent, even to nonstatisticians, the specific relationship which exists between the test and the course, thus facilitating the counselor's task of explaining the meaning of scores to students, teachers and parents."[3]

"The Differential Aptitude Tests (D.A.T.) were developed to provide an integrated, scientific, and well standardized procedure for measuring the abilities of boys and girls in grades eight through twelve for the purposes of educational and vocational guidance."[4] The test manual shows evidence of the long term consistency of measurements with the D.A.T. This means test scores can be used for long term planning as well as for more immediate goals. According to this, expectancy tables can be used for prediction several years after the tests have been administered.

Since expectancy tables are a type of validity evidence, the figures obtained from one school may or may not be representative for another school.[5] It is, therefore, considered best for each school to establish its own expectancy tables. The Guidance Department of Hays High School, Hays, Kansas has had no expectancy tables or correlation coefficients for predicting academic success up to the time this study was made.

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[2] Ibid., p. 63.

[3] Ibid., p. 64.

[4] Ibid., p. 1.

[5] Ibid., p. 64.

The need for such studies and the importance of realizing criterion variables is well stated by Doppelt and Wesman in the following quotation:

> The success of aptitude tests as predictors for different areas of endeavor will, of course, vary from one situation to another. The need for local validation studies has been well established.
>
> The primary function of aptitude tests is to predict meaningful criteria. Very often the criterion area can be readily stated in terms such as success in school or performance in a measurable and unambigious variable . . . . Teachers' grades not only include an evaluation of the students mastery of subject matter, but also a rating of the students' efforts, verbal fluency, work habits, conscientiousness and other aspects of his personality. For the teachers' purposes all these factors and probably quite a few others, should rightfully be included in an evaluation of the student. In test validation, however, the complex nature of teachers' grades tends to obscure some of the relationships which exist between the test and various aspects of grades. Further, the combination of data for students rated by different teachers raises the problem of rating standards and the inevitable question: Does an A given by Teacher "X" mean the same thing as an A given by Teacher "Y"?
>
> Despite the limitations of teachers' grades as statistical variables, we must recognize that grades are criteria in a very real sense---they are actually the principal evaluation in most school situations. It is, therefore, essential that tests intended as predictors be correlated with grades.[6]

The needs for this study then may be summarized thus:

1. General aptitude tests are an important tool of counseling and are useful in predicting school achievement.

2. Test results should be correlated with local criteria of success, which commonly are teacher grades.

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[6] J. E. Doppelt and A. G. Wesman, "Differential Aptitude Tests as Predictors of Achievement Test Scores," Journal of Educational Psychology, XLIII (April, 1952), pp. 210-17.

3. Hays High School is in need of a study of the predictive efficiency of the D.A.T. in terms of school grades.

4. For purposes of facilitating the task of explaining scores to students, teachers and parents the relationships between D.A.T. scores and grades need to be expressed in expectancy tables.

II. Related Research

The discussion in this section centers on two broad areas: general principles of prediction and the use of the D.A.T. as a predictive tool.

General Principles of Prediction

Hammond and Householder make the following comments about the nature of prediction:

> One of the reasons the scientists wants to describe the universe and all of its processes in terms of laws is because such laws, once discovered afford him brief and succinct descriptions of natural processes. Thus, the laws of physical mechanics provide a concise description of the ways in which physical bodies interact; the laws of thermodynamics economically describe the relation between motion and heat; and the laws of behavior, once they are discovered, will describe in a few words how animals and people behave under various conditions. Of course, it is the task of the behavioral scientists---the psychologists, sociologists, anthropologists, educators, and others who study the behavior of men and animals--to discover the laws of behavior. They hope thereby to increase our understanding of ourselves, and of animals as well.
>
> Once a scientific law has been firmly established, has been accepted as true, a very important change takes place. Prior to the establishment of the law, the scientific investigator simply reports what has happened under certain conditions. . . . However, once the relation repeatedly is confirmed and established as lawful, his thinking about it changes. The investigator now anticipates that what has happened will happen. For lawfulness implies that the same relation will occur again and again in the future--in fact,

> whenever it is investigated. Thus, the description applied to events which have taken place in the past can be extended now to events in the future. In short, lawfulness implies that the behavior of the events can be predicted prior to their occurrence. The law describes events not yet studied, as well as those already studied.
>
> Thus, two aspects of scientific laws are most important; not only do such laws provide succinct descriptions, but, once established, they allow us to predict.[7]

Another authority, Charles S. Pierce, is quoted by Hammond and Householder concerning scientific laws:

> There are two common characters of all the truths called laws of nature. The first of these characters is that every such law is a generalization from a collection of results of observations, gathered upon the principle that the observing was done so well to conform to outward conditions, but not selected with any regard to what the results themselves were found to be--a harvest or a gleaning of the fruit of known seed, not culled or select, but fairly representative.
>
> The second character is that a law of nature is neither a mere chance coincidence among the observations on which it has been based . . . but is of such nature that from it can be drawn an endless series of prophecies, or prediction, respecting other observations . . . ; and experiment shall verify these prophecies, though perhaps not absolutely (which would be the ideal of a law of nature), yet in the main. Nor is a proposition termed a 'law of nature' until its predictive power has been tried and proved so thoroughly that no real doubt of it remains.[8]

Scientists are able to predict and to describe many things with a great deal of precision. How is this done? What is the logic by which the scientist decides what has happened will happen again? What causes

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[7]Kenneth R. Hammond and James E. Householder, Introduction to the Statistical Method (New York: Alfred A. Knofp, 1962), p. 5.

[8]*Ibid.*, p. 7.

him, for example, to infer that because the law of gravitation held in the past it will continue to do so in the future? Hammond and Householder note that:

> . . . The scientist needs a good, commonly agreed upon, workable procedure for knowing under what conditions it is reasonable to make inductive inferences as well as how much confidence he can place in them. The statistical method fills this need.
>
> . . . .
>
> In short, behavioral scientists continue to search for those regularities which govern behavior despite the wide variations of living things in both structure and function. Clearly the task would be insurmountable were it not for the fact that the statistical method provides the techniques for reducing the chaos of individual variation to sufficient order so that the data may be understood. The statistical method provides a rigorous set of rules and procedures for making inductive inferences despite the variability that is an integral part of life.[9]

In summarizing the need for the statistical method so that prediction is possible:

> The need for the statistical method arises out of the fact that the variability among living creatures prevents easy inductive inferences; therefore, the establishment of scientific generalizations is made difficult. To cope with variability, the statistical method is used to permit inductive inferences to be made with logically defensible procedures, thus bringing the establishment of scientific generalizations within the realm of possibility. In a sense, the statistical method is a device for "extending man's reach beyond his grasp".[10]

Guilford emphasizes the importance of the scientific method to prediction in the following statements:

> One of the most important fruits of scientific investigation and one of the most exacting tests of any hypothesis is the ability

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[9] Ibid., p. 8.

[10] Ibid., p. 16.

> to make predictions . . . . Particularly is this true for the reason that statistical reasoning is basic to all predictions. Statistical ideas not only guide us in framing statements of a predictive nature but also enable us to say something definite concerning how trustworthy our predictions are---about how much error one should expect in the phenomenon predicted.[11]

Freund discusses perfect and imperfect predictions and uses the illustration from classical mythology of Oedipus, who, after a complicated series of events, did kill his father and marry his mother as was predicted. This is an example of perfect prediction which does not occur in science. Freund pointed out the difference between this type of prediction and scientific prediction:

> . . . .When a scientist predicts the occurrence of a certain event, his prediction is quite different in nature from predictions made by fortune tellers, prophets of ancient oracles and astrologers . . . . The scientist cannot predict anything whatsoever with absolute certainty. Instead, he asserts his predictions in terms of probabilities, implying that he is satisfied if his predictions come true a certain percentage of the time or, better, he aims in his predictions for a success ratio which is as high as possible.[12]

In his book, Guilford lists four cases of prediction, they are:

"1. Attributes from other attributes--as when we predict incidence of criminality from sex, race, or religious creed.

2. Attributes from quantitative measurements--as when we predict criminality from scores on tests of ability or of behavior traits.

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[11]J. P. Guilford, Fundamental Statistics in Psychology and Education (Third Edition, New York: McGraw-Hill, 1956), p. 333.

[12]John E. Freund, Modern Elementary Statistics (New Jersey: Prentice-Hall Inc., 1952), p. 235.

3. Measurements from attributes--as when we predict probable test scores from sex, socioeconomic status, or marital status.

4. Measurements from other measurements--as when we predict achievement in school from IQ-test scores."[13]

This study is an example of the last type of prediction listed, prediction of a measurement (grades) from another measurement (test scores).

The most important characteristic of any evaluative or predictive device is validity. There are four types of validity recognized by psychologists today. They are: content validity, concurrent validity, predictive validity and construct validity. Predictive validity is most useful to the counselor; it refers to how well predictions made from the test are confirmed by data collected at a later time. For example, a correlation between scores on an intelligence test with course grades provides predictive validity data. Concurrent validity refers to the accuracy with which test scores predict contemporary criterion performance. For example, a concurrent validity study might correlate end-of-course standardized achievement test scores with course grades. Content validity refers to how well the content of the test measures or samples the subject matter about which conclusions are to be drawn. Construct validity refers to an analysis of the meaning of test scores in terms of psychological concepts.

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[13]Guilford, op. cit., p. 333.

This study, being a study designed to correlate test scores and grades, was a predictive validity study. The relationships between tests and criteria were expressed by correlation coefficients. According to Doppelt and Seashore:

> The oldest and still the most widely used method for expressing the degrees of relationship between test scores and proficiency measures is the product-moment coefficient of correlation, the Pearson r.[14]

The coefficient of correlation determined by the product-moment method indicates the strength of relationship between two variables. Guilford has set up a table which roughly describes the relationship for various r's.

Less than .20	.................slight; almost negligible relationship
.20 - .40	.......low correlation; definite but small relationship
.40 - .70	.........moderate correlation; substantial relationship
.70 - .90	..................high correlation; marked relationship
.90 -1.00	....very high correlation; very dependable relationship[15]

According to Wesman, relatively few validity coefficients, especially in industry, exceed .50. Some statistics texts state that validity of this size is practically useless while at another time these same texts will review a test with validity coefficients averaging from .35 to .55 and say these tests have substantial value in predicting scholarship at the graduate level. Wesman explains this difference by pointing out that the "forecasting efficiency" as formulated in the texts is concerned with a precision of prediction much finer than that required in most situations.[16]

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[14]Jerome E. Doppelt and Harold G. Seashore, "How Effective Are Your Tests?" Test Service Bulletin, No. 37 (June, 1949), p. 4.

[15]Guilford, op. cit., p. 145.

[16]Alexander G. Wesman, "Better Than Chance," Test Service Bulletin, No. 45 (May, 1953), p. 8.

For purposes of interpreting coefficients of correlation to teachers, parents and students it frequently becomes necessary to illustrate the relationship through the use of expectancy tables.

> The product-moment correlation coefficient is commonly used by research workers as a statistical measure of the relationship between two measures of a group of individuals. In applied psychology this statistic is often used to define the correspondence between scores on tests or other measures of traits and aptitudes and a criterion of proficiency on a job, in a training course in school or industry, or some other activity. In this case the ultimate objective is to evaluate the criterion potentialities of an individual of a group on the basis of other data . . . . The concept of correlation is difficult to interpret to the nontechnically trained person. In addition, the coefficient itself provides neither the technician nor the layman with a concrete evaluative statement of the expected criterion performance of individuals with given scores on the associated variable. Accordingly, a method is needed for reinterpreting correlation coefficients in terms of the predictive significance of the association expressed in terms of simple mathematical concepts which are universally understood. Correlation coefficients may be recast as expectancy tables which show the percentage of persons making a given score on one variable who will be expected to equal or excel a given score on the associated variable . . . . An individuals test score can be interpreted in terms of that individual's chance of success. Correlation results presented in this form are readily understood by the nontechnically trained person.[17]

Cronbach adds:

> The expectancy table is a useful device for interpreting performance. To interpret a student's score, the counselor need only direct attention to the row of the table corresponding to the score; the entries show how likely the student is to attain any particular grade average. This explanation is more definite and more complete than can be offered by any other system of norms.[18]

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[17] Reign H. Bittner and Carlton E. Wilder, "Expectancy Tables: A Method of Interpreting Correlation Coefficients," Journal of Experimental Education, XIV (1946), p. 245.

[18] Lee J. Cronbach, Essentials of Psychological Testing (Second Edition, New York: Harper Brothers, 1960), p. 72.

Wesman, in an article on expectancy tables, asks the question "how much confidence may we place in the predictions made on the basis of expectancy tables."[19] In answer to this, he explains that:

> Reliability of any statistical measure varies directly with the number of individuals on which the measure is based. Since each cell is likely to contain relatively few cases, the confidence to which we are entitled is less than for measures based on larger number of cases. One should recall that the average score of a class is a more stable figure than the score of any individual student. The lesser reliability of individual cells entries (or per cents) is a real limitation of the expectancy table technique, and one of which the user should always be conscious. The limitation is not so great as to vitiate the usefulness of the device . . . larger frequencies in each cell, and consequently greater permissible confidence in our predictions may be obtained by lumping together adjacent score groups or criterion ratings. Of course, this also obscures some of the relationships. The user will have to decide which is more important in a given situation.[20]

There is another use which may be made of expectancy tables explained by Wesman as follows:

> One of the most valuable uses of an expectancy table (and of a scatter diagram) is that it helps identify the individuals for whom our predictions of success have gone astray, or those who do not conform to the usual ability patterns. By investigating the personal characteristics and backgrounds of such deviate individuals, we often find clues to unrecognized factors predictive of success or failure in a course or job.[21]

<u>The Use of the D.A.T. as a Predictive Tool</u>

The Differential Aptitude Tests were first used in 1947. According

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[19] Alexander G. Wesman, "Expectancy Tables--A Way of Interpreting Test Validity," <u>Test Service Bulletin</u>, No. 38 (December, 1949), p. 11.

[20] <u>Ibid.</u>

[21] <u>Ibid.</u>

to the test developers, they were "developed to provide an integrated, scientific and well-standardized procedure for measuring the abilities of boys and girls in grades eight through twelve for purposes of educational and vocational guidance."[22]

In the Third Mental Measurements Yearbook by Buros there is a review of the D.A.T. taken from the Journal of Consulting Psychology. According to this review:

> The publication of the Differential Aptitude Tests is a major psychometric event. The battery stresses the significance of abilities rather than "ability" as the basis for prediction and guidance at the secondary school level. The parts, other than clerical, are power tests rather than speed tests. Average reliabilities (except for that of girls on mechanical reasoning, which is .71) range from .85 to .93. Separate percentile norms are given for boys and girls from grades 8 to 12, based on national selections of from 750 to 2,000 cases for each grade-sex group for Form A, 350 to 1,100 for Form B. Profiles of percentiles and standard scores are drawn, and illustrative case studies offer some assistance to counselors in the use of results . . . .[23]

John B. Carroll gives the following review of the D.A.T. in the Fifth Mental Measurements Yearbook:

> The D.A.T. represents an attempt to measure a number of relatively distinct abilities thought to be of prime importance in assessing the potentialities of high school students. While each test has satisfactory reliability and validity in its own right, the tests are intended ordinarily to be administered

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[22]George K. Bennett, Harold G. Seashore, and Alexander G. Wesman, Differential Aptitude Tests Manual (Third Edition, New York: The Psychological Corporation, 1959), p. 1.

[23]Oscar K. Buros, The Third Mental Measurements Yearbook (New Jersey: Rutgers University Press, 1959), p. 620.

> as a total battery---not all on one day, but at least within a relatively short span of time . . . . The tests are completely objective.[24]

The scope of the test is pointed out by Super in the following:

> The test authors point out that the Differential Aptitude Tests were designed, not to measure all known and measurable aptitudes, but rather to measure a number of important variables which have meaning for vocational counseling and selection which can be assessed in a reasonable period of time.[25]

There are eight subtests included in the battery of Differential Aptitude Tests. The asterisk (*) before the tests listed below indicates those subtests used in this study.

*Verbal Reasoning
*Numerical Ability
*Abstract Reasoning
*Space Relations
Mechanical Reasoning
Clerical, Speed and Accuracy
*Language Usage: I-Spelling
II-Sentences

The authors of the D.A.T. Manual point out that in comparing scores of one school with another, it is well to remember that identical course titles do not guarantee uniformity of course content. Furthermore, grades are awarded on different bases in various schools and by individual teachers. The authors also point out "the reliability of high school grades is not known adequately, but it is certainly variable and probably lower than would be desired."[26] Another factor influencing school grades, brought out in the

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[24]Oscar K. Buros, The Fifth Mental Measurements Yearbook (New Jersey: Gryphon Press, 1959), p. 605.

[25]Donald E. Super, Appraising Vocational Fitness (New York: Harper Brothers, 1949), p. 358

[26]Bennett, Seashore, and Wesman, op. cit., p. 37.

manual, is the "halo effect" which refers to the tendency of teachers to award grades, in part, on scholastic reputation rather than on the student's actual performance. The authors feel that despite the foregoing considerations there are a large number of coefficients now available which appear to warrant the attempt to use grades as a criterion.

Anastasi has the following to say about grades as a criterion in an article on the interpretation of test scores:

> It is well known, for example, that many commonly used criteria, such as school grades or job advancement, may be influenced by many factors "extraneous" to the quality of the individual's performance. Yet, if it is our object to predict such criteria, with all their irrelevancies and shortcomings, then the correlation of a given test with such criteria is the validity of the test in that situation.
>
> If a test has been validated against a practical criterion such as school performance, the scores on such a test should be consistently defined and treated as predictors of school performance rather than measures of hypostitized and unverifiable "abilities". It is further pointed out that conditions which affect test scores may also affect the criterion, since both test scores and criteria are essentially behavior samples.[27]

A number of studies have been made in the area of prediction using the D.A.T. The manual prepared by the test authors, Bennett, Seashore and Wesman, lists most of these studies up to 1959. Although the studies differ from the present one, it was felt that helpful information could be obtained from the findings of previous investigators.

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[27]Anne Anastasi, "Concept of Validity in the Interpretation of Test Scores," Educational and Psychological Measurement, X (Spring, 1938), p. 67.

In 1947 the D.A.T. tests were launched and five years and four thousand validity coefficients later this report was written:

> In the first place, one may generalize that course grades are usually best predicted by those tests which an inexperienced counselor would expect to be the best predictors. Thus, the Sentences and Verbal tests are the best predictors of grades in English and the Numerical test is most effective in predicting mathematics and bookkeeping grades. Social studies have useful prediction in the Verbal, Sentences, and Numerical tests, and science is best predicted by the same three tests with Abstract Reasoning also useful. Shorthand is virtually always predicted by the Spelling test. The Space Relations test is effective for mechanical drawing and plane geometry. The Numerical Ability tests have been found to predict well in somewhat unexpected courses; it provides fairly good forecasting of grades in English, social studies, mechanical drawing, language and even typing. Since the content of the test seems unrelated to the nature of these courses, one can only surmise that the reasoning process it draws upon in any aspect of scholastic ability which is useful in many academic learnings.
>
> Perhaps one of the most important demonstrations provided by the thousands of validity coefficients is that of the specificity of validity. How far wrong such an implication is likely to be may be illustrated from any of the summary tables in the D.A.T. Manual. The manual reports 29 coefficients between English grades and D.A.T. verbal for boys. The highest of these validity coefficients is 0.78; the lowest is 0.19. If either of these values were only ones provided, it would be quite misleading to other users of the tests. The median coefficients of 0.48 based on 29 separate studies of boys and 0.54 based on 24 separate studies of girls are much more dependable estimates of the probable validity of the test in new situations.[28]

English grades, according to the D.A.T. Manual, are best predicted by Language Usage and Verbal Reasoning. The range of median correlations between Verbal Reasoning scores and English grades, were from .11 to .78

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[28]Alexander G. Wesman, "Differential Aptitude Tests," The Personnel and Guidance Journal, XXXI (December, 1952), p. 167.

for boys tested in the ninth grade in 21 different communities. The median r was .49 and it included students taking the test in grades eight through twelve, not just the ninth grade. The range for the ninth grade girls was .22 to .78 and the median r for the group tested in grades eight through twelve was .52. These correlations indicate how much variation there can be between schools and points to the necessity of schools establishing local correlation coefficients.

A study on predicting academic achievement with the D.A.T. and the Primary Mental Abilities Test by Wolking stated that numerical tests predict English grades as well or better than verbal tests. He also concluded that all tests (D.A.T. and P.M.A.) show their greatest effectiveness in the prediction of science, geometry and algebra grades.[29]

An explanation of why the test authors feel the Numerical Ability test is one of the best overall predictors is given as follows:

> For English and social studies as well as science and mathematics, the Numerical Ability Test is among the best predictors. One can but conjecture that facility in computation and reasoning with numbers is in some way indicative of general learning aptitude, since the specific contribution of numerical skill to English or social studies can scarcely be appreciable.
>
> Verbal Reasoning and Sentence tests have relatively high validities for predicting grades in most courses. This is probably because of the custom of awarding grades in most subjects on the basis of written reports, essay questions and other

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[29] William C. Wolking, "Predicting Academic Achievement with Differential Aptitude and Primary Abilities Tests," Journal of Applied Psychology, XXXIX (March, 1955), p. 115.

> verbal responses. These tests are measuring what is loosely called verbal intelligence which would be expected to play an important role in scholastic achievement.[30]

Jacobs made a study in Cincinnati to effectiveness of certain measures of aptitude and achievement in predicting high school academic success. There were three tests used as predictors in this study. They were: four subtests of the D.A.T. (Verbal Reasoning, Numerical Ability, Mechanical Reasoning and Language Usage); the English and Arithmetic Proficiency tests of Metropolitan Achievement Tests; and Terman McNemar Test of Mental Ability. Prediction was concerned with general academic success in the subject areas of English, mathematics, science, social studies, home economics, industrial arts, foreign language, and business education. Two criteria of success, grade point averages and scores on the Essential High School Content Battery were used in the study. Some of the findings were as follows:

(1) The areas in which the highest prediction occurred were in "tool" subjects, English, mathematics, science and social studies.

(2) Vocational subject areas were predicted less well.

(3) On the whole girls represent a more predictable group than do boys.[31]

On the basis of the survey of the general principles of prediction and of research studies especially as summarized in the D.A.T. Manual the following

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[30] Ibid., p. 38.

[31] James N. Jacobs, "Aptitude and Achievement Measures in Predicting High School Academic Success," The Personnel and Guidance Journal, XXXVII (January, 1959), p. 334.

conclusions are reached:

(1) Prediction has a scientific basis.

(2) The relationships between tests and criteria in this study are expressed as correlation coefficients.

(3) Care must be taken in interpreting the amount of relationship indicated by the correlation coefficient.

(4) Correlation coefficients may be illustrated by expectancy tables.

(5) The expectancy table is an easily interpreted and useful means of predicting grades from test scores.

(6) Confidence in the expectancy table is in proportion to the number of cases in each cell.

(7) Grades may be used as a criterion because they are commonly accepted as the principal evaluation in most school situations.

(8) The Numerical Ability Test is among the best predictors for mathematics.

(9) English grades are best predicted by Verbal Reasoning and Language Usage.

(10) Girls represent a more predictable group than do boys.

III. Statement of the Problem and Methodology

The purpose of this study was to develop expectancy tables to be used by the counselors of Hays High School in determining academic success in English, algebra and general mathematics from selected subtests of the Differential Aptitude Tests. Another aim of this study was to determine which tests were the most accurate predictors of grades.

Correlations between the tests and grades in English, algebra and general mathematics were calculated in order to obtain a more accurate statistical measure of the relationships between selected tests of the Differential Aptitude Tests and grades received in English, algebra and general mathematics.

To calculate the correlation coefficients, the Pearson product-moment formula was used. It was necessary to calculate separate correlations and expectancy tables for boys and girls because they have different norms.

The subjects selected for this study were English I, Algebra I and General Mathematics. These subjects were selected because they were required of all ninth grade students at Hays High School. A choice was given between Algebra I or General Mathematics but all were required to take English I.

The tests used for prediction were selected from the Differential Aptitude Tests. The D.A.T. Manual was used to determine what was measured by each of the subtests. The tests selected for each subject were as follows:

English

Verbal Reasoning	because it measures ability to understand concepts framed in words and ability to think constructively.
Numerical Ability	because it is said to be one of the best predictors of English.
Spelling (LU-I)	because it is said to be an effective predictor of English grades.
Sentences (LU-II)	because it attempts to measure the students' ability to distinguish good and bad grammar, punctuation and word usage, all essential in English.

Algebra

Verbal Reasoning	because it shows the ability to understand concepts framed in words and to think constructively.
Numerical Ability	because it is designed to test understanding of numerical concepts.
Abstract Reasoning	because this test is a non-verbal measure of students' ability and also because it supplements the general intelligence aspects of the Verbal and Numerical tests.
Space Relations	because it is valuable as a predictor in plane geometry and it may effectively predict achievement in general mathematics and algebra.

General Mathematics

The tests selected for general mathematics were the same as those used for algebra.

The students used in this study were sophomores, juniors and seniors at Hays High School who were given Form A of the Differential Aptitude Test while in the ninth grade. The test was administered to 329 students but 23 were eliminated for the following reasons: because they did not take all of the tests, they withdrew from school, they moved during the year and subject grades were not available. Of the 306 included in the study, 155 were boys and 151 were girls.

The grades for this study were final grades in the subject. The following values were assigned to the letter grades for figuring grade point average: A = 5 points, B = 4 points, C = 3 points, D = 2 points and F = 1 point.

The norms used were the 1952 norms published in the D.A.T. Manual. Mean test scores were calculated and compared with the D.A.T. norms. The mean grade point average and distribution of grades were computed to provide additional information for the study.

The data for the study were tabulated and expressed in percents on the expectancy tables. Percentages were used because the student's chance for success was most easily understood by expressing it in percent. Twelve expectancy tables were made, each containing a table for girls and one for boys.

Correlations were calculated to determine more accurately the relationship between selected tests of the D.A.T. and grades in English, algebra and general mathematics. Four tests were correlated with each subject making a total of twenty-four correlations, twelve for girls and twelve for boys.

A significance of difference was computed to determine whether one test predicted grades in a subject better than another. The method of finding the significance of difference was described by Edwards as follows:

> In some cases we wish to test significance of differences between two correlation coefficients when the two values are not independent. Example--measures on three variables X_1 and X_2 and Y for a group of N subjects. We denote the two correlations of X_1 and X_2 with Y by r_1 and r_2 and the correlation between X_1 and X_2 by r_{12}. To determine whether r_1 and r_2 differ significantly, we use a test due to Hotelling.
>
> $$t = (r_1 - r_2)\sqrt{\frac{(N-3)\ (1+r_{12})}{2(1-r_1^2-r_2^2-r_{12}^2 + 2r_1 r_2 r_{12})}}$$
>
> We find with n-3 d.f. the t obtained with formula above can be evaluated for significance by referring to the table of t with n-3 d.f.[32]

---

[32]Allen P. Edwards, Experimental Design in Psychological Research (New York: Rinehart and Company, Inc., 1950), p. 85.

Guilford's tables for determining significance were consulted to find the significance of the t determined by the formula given on page 21. If the t was significant at the .01 or the .05 level, the test with the highest correlation was said to be a better predictor than the test with which it was compared. If the t was not significant, it meant the correlations were too close for one to be considered a statistically better predictor than the other.

Multiple correlations were computed to determine if a combination of two test scores would be a more accurate predictor of grades in a subject than a single test score. Eighteen expectancy tables were prepared for the multiple correlations, nine tables for girls and nine for boys.

CHAPTER II

ANALYSIS OF THE DATA

Various statistical measurements were used to determine a statistical basis for prediction of academic success from test scores. Measurements used were: means; coefficients of correlation, standard deviations, multiple correlations; and the significance of difference between coefficients of correlations.

I. Means

The present norms (1952) found in the Differential Aptitude Test Manual included over 47,000 students. The mean scores of the sample were compared with norms of the D.A.T. (Table I).

The mean of the test scores for the girls of the Hays High School sample were as follows: the mean of the sample was 19.7 in Verbal Reasoning which was one point higher than the norm of 18.7; the mean of the sample in Numerical Ability was 20.0 which was 3.9 points higher than the norm of 16.1; the mean was 25.2 in Abstract Reasoning which was 2.1 higher than the norm of 23.1; the mean of Space Relations was 40.8 which was seven points higher than the norm of 33.8; the mean of 44.1 in Spelling was 0.1 higher than the norm of 44.0; and the mean score of 30.9 in Sentences was 0.7 of a point below the norm of 31.6.

The mean scores for the boys of the Hays High School sample were as follows: the mean score was 20.0 in Verbal Reasoning which was 1.7 points

TABLE I

THE MEAN SCORES OF HAYS HIGH SCHOOL STUDENTS
IN COMPARISON WITH THE D.A.T. NORMS

D.A.T. Tests	MEAN SCORES			
	Girls (N=151)		Boys (N=155)	
	HAYS HIGH	D.A.T.	HAYS HIGH	D.A.T.
Verbal Reasoning	19.7	18.7	20.0	18.3
Numerical Ability	20.0	16.1	20.5	16.3
Abstract Reasoning	25.2	23.1	26.5	24.1
Space Relations	40.8	33.8	43.9	39.1
Spelling	44.1	44.0	27.7	31.1
Sentences	30.9	31.6	22.9	23.7

above the norm of 18.3; the mean of the sample was 20.5 in Numerical Ability which was 4.2 points higher than the norm of 16.3; the mean of the sample in Abstract Reasoning was 26.5 which was 2.4 points higher than the norm of 24.1; the mean of 43.9 in Space Relations was 4.7 points higher than the norm of 39.1; the mean of 27.7 in Spelling was 3.4 points higher than the norm of 31.1; the mean of 22.9 in Sentences was 0.8 of a point lower than the norm of 23.7.

The means of the sample used for this study averaged above the mean scores of the D.A.T. norms. The mean scores of the girls were found to be slightly higher than those of the boys.

The mean grade point averages in each subject were calculated in order to give a more complete picture of the sample of students used in this study (Table II). The mean grade point average of the girls was higher than the mean of the boys in all three subjects. The girls' highest grade point was in English, with algebra next; the boys' highest grade point was in algebra with English second highest. This supports previous assumptions that girls are better in English than in mathematics, and that boys are better in mathematics than in English.

TABLE II

MEAN GRADE POINT AVERAGES OF
HAYS HIGH SCHOOL STUDENTS

Subject	Grade Point Average	
	Girls	Boys
English	3.68	2.89
Algebra	3.32	3.07
General Mathematics	2.86	2.67

The distribution of grades in subjects is shown in Table III. In Table III the girls and boys show less difference in the distribution of grades between sexes in mathematics than in English. Seventy-five per cent of the girls and 65% of the boys made C or better grades in algebra. In general mathematics, 55% of the girls and 57% of the boys made C or better. Grades in English showed a greater difference in distribution of grades. In English, 81% of the girls and 61% of the boys made grades of C or better. This may be attributed to the "halo effect" of grading or to some sex difference in awarding grades in English. It may be that the girls work harder, get their work in on time and feel they should do well in English. The reluctance to get book reports and themes in on time, lack of motivation and interest in English or an "I don't care" attitude may be factors that keep some of the boys from doing better.

TABLE III

DISTRIBUTION OF GRADES

Subject		A	B	C	D	F	Total
English	Girls	26	67	30	21	7	151
	Boys	13	30	51	49	12	155
Algebra	Girls	24	23	38	24	5	114
	Boys	20	19	38	37	4	118
General Mathematics	Girls	2	8	11	17	0	38
	Boys	2	5	19	16	4	46

Algebra is selected by roughly two-thirds of the students at Hays High School. This selection is based on a liking for mathematics or a need for the course because of further educational requirements. As a result, the ability of this group is average or above average. A student with less ability in this class usually realizes his handicap and works hard to make average grades or transfers to general mathematics.

General mathematics is the alternate choice for students not wishing to take algebra. Occasionally students with more than average ability will take the course to "get by" or to make an easy grade. Most students taking general mathematics are low in ability, do not like mathematics or avoid a course that is known to be more difficult.

Comparisons with the D.A.T. norms and students in general mathematics were not too reliable because of the small sample (38 girls and 46 boys) and level of ability in the group.

II. Expectancy Tables

Expectancy tables give a graphic explanation of the predictions which may be made. The tables on the following pages predict grades in English, algebra and general mathematics for students of Hays High School from percentile scores on selected tests of the D.A.T. Twelve expectancy tables were prepared which contained separate tables for girls and for boys (Tables IV-XV).

The primary use of the expectancy table is to predict a student's chance of scholastic success as determined by grades. Another use of the expectancy table is to provide illustrative information regarding the spread or concentration of scores as in a scatter diagram.

Tables IV was used as an example to illustrate the method of interpretation of the expectancy tables. The column at the left contains the percentile scores divided into quintiles, and the letters across the top represent letter grades. The last column contains the number of cases in each quintile. The percents in each of the "cells" of the table indicate the chance in a hundred of making a particular grade. If a girl's score on the Verbal Reasoning test in English was in the 0-19 quintile, her chances of making an A were zero; of making a B, 12 out of 100; of making a C, 31 out of 100; of making a D, 46 out of 100; and of making an F, 12 out of 100. If a boy scores in the same quintile on the same test, his chance of making an A was zero; of making a B, 4 out of 100; of making a C, 14 out of 100; of making a D, 64 out of 100; and of making an F, 18 out of 100. It was interesting to note from the table that of the 26 girls in this quintile, 43% of them made a C or better and of the 22 boys in this quintile, only 18% made C's or better.

The other expectancy tables are similarly interpreted.

TABLE IV

EXPECTANCY TABLES FOR PREDICTING GRADES IN ENGLISH FROM PERCENTILE SCORES ON THE D.A.T. VERBAL REASONING TEST

GIRLS

r = .67
SD = 9.0

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99			5	46	49	41
60-79	3	6	6	78	6	32
40-59		7	30	50	13	30
20-39	14	27	36	23		22
0-19	12	46	31	12		26

BOYS

r = .68
SD = 8.8

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99	2	2	27	39	29	41
60-79		23	50	25	3	40
40-59	14	34	41	10		29
20-39	13	65	22			23
0-19	18	64	14	4		22

NOTE: The numbers in the expectancy tables are percentages.

TABLE V

EXPECTANCY TABLES FOR PREDICTING GRADES IN ENGLISH FROM PERCENTILE SCORES ON THE D.A.T. NUMERICAL ABILITY TEST

GIRLS

r = .57
SD = 6.9

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99		4	7	56	33	54
60-79	3	5	20	55	18	40
40-59	11	33	22	30	4	27
20-39	9	27	41	23		22
0-19	13	25	50	13		8

BOYS

r = .59
SD = 7.3

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99		11	34	34	21	56
60-79	11	32	38	17	2	47
40-59	14	45	36	5		22
20-39	13	58	21	8		24
0-19	17	67	17			6

TABLE VI

EXPECTANCY TABLES FOR PREDICTING GRADES IN ENGLISH FROM PERCENTILE SCORES ON THE D.A.T. SPELLING TEST

GIRLS

r = .60
SD =26.4

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99		3	3	57	38	37
60-79			17	70	13	30
40-59	4		29	50	17	24
20-39	11	22	26	37	4	27
0-19	9	43	30	9	9	33

BOYS

r = .61
SD =24.4

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99		3	32	35	29	31
60-79		27	38	19	15	26
40-59	4	27	38	31		26
20-39	11	70	48	7		27
0-19	23	43	23	11		35

TABLE VII

EXPECTANCY TABLES FOR PREDICTING GRADES IN ENGLISH FROM PERCENTILE SCORES ON THE D.A.T. SENTENCES TEST

GIRLS

r = .62
SD =14.8

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99			3	50	47	32
60-79		9	12	65	15	34
40-59		4	24	52	20	25
20-39	9	23	34	31	3	35
0-19	16	36	28	20		25

BOYS

r = .66
SD =14.7

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99		7	20	37	37	30
60-79		22	41	34	3	32
40-59	6	26	46	20	3	35
20-39	13	37	50			30
0-19	21	71	4	4		28

TABLE VIII

EXPECTANCY TABLES FOR PREDICTING GRADES IN ALGEBRA FROM PERCENTILE SCORES ON THE D.A.T. VERBAL REASONING TEST

GIRLS

r = .65
SD = 6.9

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99		15	18	26	41	39
60-79		14	43	32	11	28
40-59	8	16	44	12	20	25
20-39	18	45	27	9		11
0-19	9	45	45			11

BOYS

r = .55
SD= 8.7

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99		15	23	26	36	39
60-79		39	36	14	11	36
40-59	11	39	33	6	11	18
20-39	8	31	54	8		13
0-19	9	55	27	9		11

TABLE IX

EXPECTANCY TABLES FOR PREDICTING GRADES IN ALGEBRA FROM PERCENTILE SCORES ON THE D.A.T. NUMERICAL ABILITY TEST

GIRLS

r = .50
SD = 8.7

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99	2	4	21	28	45	47
60-79	3	21	36	30	9	33
40-59	11	50	39			18
20-39		55	45			11
0-19	20		80			5

BOYS

r = .63
SD = 7.6

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99	2	12	24	24	38	50
60-79	6	43	37	11	3	35
40-59		43	50	7		14
20-39		59	29	12		17
0-19	50		50			2

TABLE X

EXPECTANCY TABLES FOR PREDICTING GRADES IN ALGEBRA FROM PERCENTILE SCORES ON THE D.A.T. ABSTRACT REASONING TEST

GIRLS

r = .46
SD =10.8

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99		9	28	28	35	43
60-79		11	53	16	21	19
40-59	9	32	18	18	23	22
20-39	11	21	47	21		19
0-19	9	64	27			12

BOYS

r = .53
SD =11.0

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99		12	28	23	37	43
60-79		39	26	26	9	23
40-59	12	38	38	4	8	26
20-39		55	45			11
0-19	7	47	33	13		15

TABLE XI

EXPECTANCY TABLES FOR PREDICTING GRADES IN ALGEBRA FROM PERCENTILE SCORES ON THE D.A.T. SPACE RELATIONS TEST

GIRLS

r = .41
SD =22.4

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99	2	10	27	25	35	51
60-79	4	17	39	17	22	23
40-59		38	38	15	8	13
20-39	11	39	28	22		18
0-19	11	33	56			9

BOYS

r = .46
SD =22.3

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99		17	32	21	30	47
60-79	4	32	39	18	7	28
40-59		44	38	6	13	16
20-39	12	35	29	12	12	17
0-19	10	70	10	10		10

TABLE XII

EXPECTANCY TABLES FOR PREDICTING GRADES IN GENERAL MATH FROM PERCENTILE SCORES ON THE D.A.T. VERBAL REASONING TEST

GIRLS

r = .46
SD = 5.7

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99				100		1
60-79		20	20	20	40	5
40-59		50	33	17		6
20-39		36	36	27		11
0-19		60	27	13		15

BOYS

r = .03
SD = 6.0

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99		50	50			2
60-79	17	33	17	17	17	6
40-59	13	33	27	20	7	15
20-39		36	64			11
0-19	8	33	50	8		12

TABLE XIII

EXPECTANCY TABLES FOR PREDICTING GRADES IN GENERAL MATH FROM PERCENTILE SCORES ON THE D.A.T. NUMERICAL ABILITY TEST

GIRLS

r = .52
SD = 5.9

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99		13	13	63	13	8
60-79		57	14	14	14	9
40-59		40	40	20		10
20-39		44	56			9
0-19		100				4

BOYS

r = .34
SD = 5.6

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99		56	11	33		9
60-79	13		63	13	13	16
40-59		56	44			9
20-39	11	44	44			9
0-19	33	67				3

TABLE XIV

EXPECTANCY TABLES FOR PREDICTING GRADES IN GENERAL MATH FROM PERCENTILE SCORES ON THE D.A.T. ABSTRACT REASONING TEST

GIRLS

r = .19
SD =10.6

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99		67	33			3
60-79		43	14	14	29	7
40-59		25	42	33		12
20-39		50	17	33		6
0-19		60	30	10		10

BOYS

r = .26
SD = 8.2

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99			100			1
60-79		25	63		13	8
40-59		37	32	16		19
20-39	16	20	40	20	10	10
0-19	10	63	38			8

TABLE XV

EXPECTANCY TABLES FOR PREDICTING GRADES IN GENERAL MATH FROM PERCENTILE SCORES ON THE D.A.T. SPACE RELATIONS TEST

GIRLS

r = .34
SD =18.1

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99		33		34	33	3
60-79		45	18	27	9	11
40-59		25	75			4
20-39		36	27	36		11
0-19		67	33			9

BOYS

r = .05
SD =18.4

Percentile Score	F	D	C	B	A	Total No. of Cases
80-99		33	34		33	3
60-79	29	29	43			7
40-59	13	25	25	38		8
20-39	6	29	53	6	6	17
0-19		55	36	9		11

III. Correlations

All the correlation coefficients in English and algebra were significant at the .01 level. In general mathematics, the girls' Verbal Reasoning and Numerical Ability correlations were significant at the .01 level and the Space Relations test was significant at the .05 level. For boys the only coefficient of correlation in general mathematics that had significance (.05 level) was Numerical Ability.

Tables XVI, XVII and XVIII list the coefficients of correlations, the standard deviations and the level of significance for all correlations. Correlations were calculated between test scores and grades in English. The highest coefficient of correlation for girls was between Verbal Reasoning and grades in English (.67) with Sentences (.62) and Spelling (.60) in second and third place. The correlation between Numerical Ability and English was .57. For boys, the highest correlation was between Verbal Reasoning (.68) and grades in English with Sentences (.66) and Spelling (.61) in second and third place. The correlation between Numerical Ability and grades in English was .59.

TABLE XVI

CORRELATIONS OF D.A.T. SCORES AND COURSE GRADES IN ENGLISH

D.A.T. Test	Girls (N=151) r	Girls (N=151) SD	Boys (N=155) r	Boys (N=155) SD
Verbal Reasoning	*.671	9.0	*.684	8.8
Numerical Ability	*.567	6.9	*.593	7.3
LU:1 Spelling	*.602	26.4	*.609	24.4
LU:2 Sentences	*.622	14.8	*.663	14.7

*Significant at the .01 level.

Correlations were calculated between test scores and grades in algebra. The highest coefficient of correlation (.65) for girls was between Verbal Reasoning and grades in algebra with Numerical Ability (.50) and Abstract Ability (.46) in second and third place. The correlation between grades in algebra and Space Relations was .41. For boys, the highest correlation (.63) was between Numerical Ability and grades in algebra with Verbal Reasoning (.55) and Abstract Reasoning (.54) in second and third place. The correlation between grades in algebra and Space Relations was .46.

TABLE XVII

CORRELATIONS OF D.A.T. SCORES AND COURSE GRADES IN ALGEBRA

D.A.T. Test	Girls (N=114) r	Girls (N=114) SD	Boys (N=118) r	Boys (N=118) SD
Verbal Reasoning	*.649	6.9	*.554	8.7
Numerical Ability	*.503	8.7	*.628	7.6
Abstract Ability	*.464	10.8	*.536	11.0
Space Relations	*.414	22.36	*.459	22.3

*Significant at the .01 level

Correlations were also calculated between test scores and grades in general mathematics. The highest coefficient of correlation (.52) for girls was between Numerical Ability and grades in general mathematics with Verbal Reasoning (.46) and Space Relations (.34) in second and third place. The correlation between grades in general mathematics and Abstract Reasoning was .19. For boys, the highest correlation (.34) was between Numerical Ability and grades in general mathematics with Abstract Reasoning (.26) second high. The correlations between grades in general mathematics and Space Relations was .05 and with Verbal Reasoning .03.

TABLE XVIII

CORRELATIONS OF D.A.T. SCORES AND
COURSE GRADES IN GENERAL MATHEMATICS

D.A.T. Test	Girls (N=38) r	Girls (N=38) SD	Boys (N=46) r	Boys (N=46) SD
Verbal Reasoning	*.460	5.7	.029	6.0
Numerical Ability	*.523	5.9	**.338	5.6
Abstract Reasoning	.188	10.6	.263	8.2
Space Relations	**.343	18.1	.045	18.4

*Significant at the .01 level
**Significant at the .05 level

Table XIX shows the significance of difference between the highest and lowest coefficients of correlation. The table also indicates if the difference was significant at the .01 or .05 level.

The correlation between Verbal Reasoning and grades in English was significantly higher than the correlation between Numerical Ability and grades in English, for both boys and girls. Therefore, Verbal Reasoning was found to be a better predictor than Numerical Ability of grades in English at Hays High School.

The correlation between Numerical Ability and grades in general mathematics was significantly higher for girls than the correlation between Abstract Reasoning and grades in general mathematics. Therefore, Numerical Ability was found to be a better predictor than Abstract Reasoning of grades in general mathematics at Hays High School.

The correlation between Numerical Ability and grades in algebra was significantly higher for boys than the correlation between Space Relations and grades in algebra. Therefore, Numerical Ability was found to be a better predictor than Space Relations for prediction of grades in algebra at Hays High School.

Multiple correlations were computed for grades in English, algebra and general mathematics (Table XX). The three tests which showed the highest degree of relationship with each of the three subject areas were used.

The multiple correlation between grades in English and Sentences and Spelling was .77 for girls and .68 for boys; between English grades and

TABLE XIX

SIGNIFICANCE OF DIFFERENCE BETWEEN
HIGHEST AND LOWEST CORRELATIONS

Grades	Highest Correlation	Lowest Significant Correlation	Girls t	Boys t
			(N=151)	(N=155)
English	Verbal Reasoning	Numerical Ability	**1.99	*2.92
	Verbal Reasoning	Spelling	1.29	1.42
			(N=114)	(N=118)
Algebra	Numerical Ability	Abstract Reasoning	.413	1.57
	Numerical Ability	Space Relations	.985	**2.25
			(N = 38)	(N = 46)
General Mathematics	Numerical Ability	Abstract Reasoning	**2.05	.47
	Numerical Ability	Space Relations	1.15	

*Significant at the .01 level
**Significant at the .05 level

Verbal Reasoning and Sentences, .70 for girls and .75 for boys; between English grades and Verbal Reasoning and Spelling, .69 for girls and .74 for boys.

The multiple correlation between grades in algebra and Verbal Reasoning and Abstract Reasoning was .86 for girls and .59 for boys; between grades in algebra and Verbal Reasoning and Numerical Ability, .66 for girls and .66 for boys; and between grades in algebra and Abstract Reasoning and Numerical Ability, .63 for girls and .65 for boys.

The multiple correlation between grades in general mathematics and Verbal Reasoning and Numerical Ability was .61 for girls and .36 for boys; between grades in general mathematics and Abstract Reasoning and Numerical Ability .52 for girls and .37 for boys; and between grades in general mathematics and Verbal Reasoning and Abstract Reasoning .46 for girls and .27 for boys.

Expectancy tables were prepared for all multiple correlations. They were constructed and interpreted the same as the first group of tables except that raw scores instead of percentile scores were used (Tables XXI-XXIX). The multiple correlation coefficient given with each table indicates the relationship between English, algebra <u>or</u> general mathematics and two predictor variables but it does not give a perfectly accurate estimate of the relationship of the scores expressed in the expectancy table. The formula used in determining multiple correlations assumes that raw scores were optimally weighted. The scores on the tables were not so weighted and thus the multiple R's should not be used in connection with the expectancy tables.

TABLE XX

MULTIPLE CORRELATIONS FOR PREDICTION OF GRADES IN ENGLISH, ALGEBRA AND GENERAL MATHEMATICS

Prediction of grades in:	D.A.T Tests	Girls R	Boys R
		(N=151)	(N=155)
English	Verbal Reasoning Sentences	*.703	*.751
	Verbal Reasoning Spelling	*.689	*.742
	Sentences Spelling	*.775	*.678
		(N=114)	(N=118)
Algebra	Numerical Ability Verbal Reasoning	*.664	*.659
	Numerical Ability Abstract Reasoning	*.631	*.649
	Verbal Reasoning Abstract Reasoning	*.856	*.591
		(N = 38)	(N = 46)
General Mathematics	Numerical Ability Verbal Reasoning	*.608	.357
	Numerical Ability Abstract Reasoning	*.523	**.368
	Verbal Reasoning Abstract Reasoning	**.460	.266

*Significant at the .01 level
**Significant at the .05 level

TABLE XXI

EXPECTANCY TABLES FOR PREDICTING GRADES IN ENGLISH FROM THE COMBINED RAW SCORES OF THE D.A.T. VERBAL REASONING AND SENTENCES

GIRLS

R = .70

Raw Scores	F	D	C	B	A	Total No. of Cases
140-159						
120-139						
100-119				75	25	4
80-99			27	73		11
60-79			5	68	28	40
40-59	2	9	23	51	14	43
20-39	8	28	40	25		40
0-19	23	46	23	8		13

BOYS

R = .75

Raw Scores	F	D	C	B	A	Total No. of Cases
140-159						
120-139						
100-119						
80-99				45	55	11
60-79		5	32	37	26	19
40-59	2	21	46	27	4	56
20-39	15	40	40	4		47
0-19	18	77		5		22

*The numbers in the expectancy tables are percentages.

TABLE XXII

EXPECTANCY TABLES FOR PREDICTING GRADES IN ENGLISH FROM THE COMBINED RAW SCORES OF THE D.A.T. VERBAL REASONING AND SPELLING

GIRLS

R = .69

Raw Scores	F	D	C	B	A	Total No. of Cases
140-159						
120-139				40	60	5
100-119				36	64	11
80-99				74	26	34
60-79		3	30	57	11	37
40-59	9	14	32	41	5	22
20-39	9	35	30	17	9	23
0-19	16	47	32	5		19

BOYS

R = .74

Raw Scores	F	D	C	B	A	Total No. of Cases
140-159						
120-139				25	75	4
100-119				40	60	5
80-99		5	35	35	25	20
60-79		14	48	29	10	21
40-59		30	40	30		30
20-39	7	44	40	9		45
0-19	30	53	13	3		30

TABLE XXIII

EXPECTANCY TABLES FOR PREDICTING GRADES IN ENGLISH FROM THE COMBINED RAW SCORES OF THE D.A.T. SENTENCES AND SPELLING

GIRLS

R = .77

Raw Scores	F	D	C	B	A	Total No. of Cases
140-159				40	60	5
120-139				39	61	18
100-119		7	7	67	20	15
80-99			18	65	18	34
60-79			36	64		22
40-59	7	29	25	32	7	28
20-39	23	23	38	8	8	13
0-19	13	56	25	6		16

BOYS

R = .68

Raw Scores	F	D	C	B	A	Total No. of Cases
140-159				60	40	5
120-139				25	75	4
100-119			29	29	43	7
80-99		5	45	30	20	20
60-79		26	42	26	5	19
40-59		30	37	33		27
20-39	7	44	44	5		41
0-19	28	53	13	6		32

TABLE XXIV

EXPECTANCY TABLES FOR PREDICTING GRADES IN ALGEBRA FROM THE COMBINED RAW SCORES OF THE D.A.T. NUMERICAL ABILITY AND VERBAL REASONING

GIRLS

R = .66

Raw Score	F	D	C	B	A	Total No. of Cases
80-99						
60-79			7	27	67	15
40-59	2	14	30	29	25	56
20-39	11	34	21	8		38
0-19		60	40			5

BOYS

R = .66

Raw Score	F	D	C	B	A	Total No. of Cases
80-99						
60-79			13	27	60	15
40-59	2	25	33	22	18	55
20-39	4	49	38	7	2	45
0-19	33	33	33			3

TABLE XXV

EXPECTANCY TABLES FOR PREDICTING GRADES IN ALGEBRA FROM THE COMBINED RAW SCORES OF THE D.A.T. NUMERICAL ABILITY AND ABSTRACT REASONING

GIRLS

R = .63

Raw Score	F	D	C	B	A	Total No. of Cases
80-99						
60-79		4	14	36	46	28
40-59	2	20	39	19	20	54
20-39	15	27	46	12		26
0-19		83	17			6

BOYS

R = .65

Raw Score	F	D	C	B	A	Total No. of Cases
80-99				20	80	5
60-79			26	26	48	27
40-59	5	37	35	18	5	57
20-39		54	46			24
0-19	20	60		20		5

TABLE XXVI

EXPECTANCY TABLES FOR PREDICTING GRADES IN ALGEBRA FROM THE COMBINED RAW SCORES OF THE D.A.T. VERBAL REASONING AND ABSTRACT REASONING

GIRLS

R = .86

Raw Score	F	D	C	B	A	Total No. of Cases
80-99						
60-79		6	22	33	39	36
40-59	2	25	35	17	21	48
20-39	14	18	55	14		22
0-19	13	75	13			8

BOYS

R = .59

Raw Score	F	D	C	B	A	Total No. of Cases
80-99				20	80	5
60-79		9	25	31	34	32
40-59	4	39	35	12	10	49
20-39	4	44	48	4		25
0-19	14	57	14	14		7

TABLE XXVII

EXPECTANCY TABLES FOR PREDICTING GRADES IN GENERAL MATHEMATICS FROM THE COMBINED RAW SCORES OF THE D.A.T. NUMERICAL ABILITY AND VERBAL REASONING

GIRLS

R = .61

Raw Score	F	D	C	B	A	Total No. of Cases
80-99						
60-79						
40-59		25		50	25	4
20-39		37	37	22	4	27
0-19		86	14			7

BOYS

R = .36

Raw Score	F	D	C	B	A	Total No. of Cases
80-99						
60-79						
40-59		36	27	27	9	11
20-39	10	32	48	6	3	31
0-19	25	50	25			4

TABLE XXVIII

EXPECTANCY TABLES FOR PREDICTING GRADES IN GENERAL MATHEMATICS FROM THE COMBINED RAW SCORES OF THE D.A.T. NUMERICAL ABILITY AND ABSTRACT REASONING

GIRLS

R = .52

Raw Score	F	D	C	B	A	Total No. of Cases
80-99						
60-79					100	1
40-59		35	24	35	6	17
20-39		50	42	8		12
0-19		63	25	13		8

BOYS

R = .37

Raw Score	F	D	C	B	A	Total No. of Cases
80-99						
60-79						
40-59	4	29	46	17	4	24
20-39	17	33	39	6	6	18
0-19		75	25			4

TABLE XXIX

EXPECTANCY TABLES FOR PREDICTING GRADES IN GENERAL MATHEMATICS FROM THE COMBINED RAW SCORES OF THE D.A.T. VERBAL REASONING AND ABSTRACT REASONING

GIRLS

R = .46

Raw Score	F	D	C	B	A	Total No. of Cases
80-99						
60-79						
40-59		36	27	18	18	11
20-39		39	28	36		18
0-19		67	33			9

BOYS

R = .27

Raw Score	F	D	C	B	A	Total No. of Cases
80-99						
60-79			100			1
40-59	11	47	32	5	5	19
20-39	9	18	50	18	5	22
0-19		75	25			4

CHAPTER III

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Expectancy tables were prepared for use at Hays High School and correlations were calculated to obtain a more accurate statistical measure of the relationships between selected tests of the Differential Aptitude Tests and grades received in English, algebra and general mathematics.

Differential Aptitude Test scores and grades of 306 Hays High School students were used in this study. Of the 306 students, 151 were girls and 155 boys. The D.A.T. tests were administered to the students while they were in the ninth grade and the grades used were end-of-year grades in English I (ninth grade English), Algebra I and General Mathematics.

The mean scores of the sample from Hays High were found to be comparable to the norms of the D.A.T. The mean scores in Verbal Reasoning, Numerical Ability, Abstract Reasoning and Space Relations were above the norms of the D.A.T. for both boys and girls. The mean score in Spelling for the girls was the same as the D.A.T. norms while the boys' mean in Spelling was slightly below the norms. The mean for Hays High School in Sentences was less than one point below the normative group for both girls and boys.

The girls of the sample had a higher grade point average than the boys in each of the subjects used. The distribution of grades was normal in mathematics but this did not seem to be quite as true in English. In English, 81% of the girls made grades of C or better whereas only 61% of the boys made C or better.

Correlations between the D.A.T. tests and grades in subjects are summarized as follows:

The correlation between Verbal Reasoning and grades in English was .67 for the girls and .68 for boys with both coefficients significant at the .01 level.

The correlation between Numerical Ability and grades in English was .57 for the girls and .59 for boys with both coefficients significant at the .01 level.

The correlation between Spelling and grades in English was .60 for the girls and .61 for boys with both coefficients significant at the .01 level.

The correlation between Sentences and grades in English was .62 for the girls and .66 for boys with both coefficients significant at the .01 level.

The correlation between Verbal Reasoning and grades in algebra was .50 for the girls and .63 for boys with both coefficients significant at the .01 level.

The correlation between Abstract Ability and grades in algebra was .46 for the girls and .54 for boys with both coefficients significant at the .01 level.

The correlation between Space Relations and grades in algebra was .41 for the girls and .46 for boys with both coefficients significant at the .01 level.

The correlation between Verbal Reasoning and general mathematics was .46 for the girls and .03 for boys with the correlation for the girls the only one significant at the .01 level.

The correlation between Numerical Ability and grades in general mathematics was .52 for the girls with this coefficient significant at the .01 level and .34 for the boys with this coefficient significant at the .05 level.

The correlation between Abstract Reasoning and general mathematics was .19 for the girls and .26 for boys, with neither being significant at the .01 or .05 level.

The correlation between Space Relations and general mathematics was .34 for the girls (significant at the .05 level) and .05 for boys (which was not significant).

To determine whether one test had a significantly higher relationship with subject grades than another, the significance of difference was statistically determined. Correlations between grades in English and Verbal Reasoning, Numerical Ability, Spelling and Sentence test scores were all significant. However, Verbal Reasoning showed a significantly higher relationship to grades in English than did Numerical Ability. Correlations between grades in algebra and Verbal Reasoning, Numerical Ability, Abstract Reasoning and Space Relations were all significant. For boys, however, Numerical Ability showed a significantly higher relationship to grades in algebra than did Space Relations. The correlations between grades in general mathematics and Verbal Reasoning, Numerical Ability and Space Relations were significant for the girls. However, Numerical Ability showed a significantly higher relationship to general mathematics than did Abstract Reasoning. The correlation between Numerical Ability and grades in general mathematics for the boys was not significant.

According to Guilford's table on page 9 correlation coefficients of the magnitude obtained in this study by comparing tests with English and algebra grades indicate the existence of a substantial relationship. Therefore, these correlations can be used for prediction of success in English and algebra at Hays High School.

The highest multiple correlation found for English was one of .77 between grades in English and a combination of Sentences and Spelling scores for girls. The highest multiple correlation for boys was .75 between grades in English and the combined Verbal Reasoning and Sentences score.

The highest multiple correlation (.86) for girls in algebra was between grades in algebra and the combination of Verbal Reasoning and Abstract Reasoning. The boys' highest multiple correlation in algebra (.66) was between grades in algebra and the combined scores of Verbal Reasoning and Numerical Ability. The correlation of .86 between grades in algebra and the combination of Verbal Reasoning and Abstract Reasoning for the girls was the highest multiple correlation calculated.

The highest multiple correlation (.61) for predicting grades in general mathematics for girls was between grades in general mathematics and the combination of Verbal Reasoning and Numerical Ability. The boys' highest correlation (.37) was between grades in general mathematics and the combined scores of Abstract Reasoning and Numerical Ability. The last multiple correlation coefficient was significant at the .05 level and all other multiple correlations mentioned were significant at the .01 level.

Expectancy tables were prepared illustrating each of the relationships studied. These tables should prove especially useful in interpreting test score results to teachers, parents and students of Hays High School.

In summary this study found that:

(1) In general, the D.A.T. tests can be used with confidence for prediction of English and algebra grades at Hays High School.

(2) Hays High School students compared favorably with the norms of the D.A.T.

(3) Verbal Reasoning, Numerical Ability, Spelling and Sentences showed a significant relationship with achievement in English. Verbal Reasoning was found to be a significantly better predictor than Numerical Ability which had the lowest relationship with achievement.

(4) Verbal Reasoning, Numerical Ability, Abstract Reasoning and Space Relations showed a significant relationship with achievement of boys in algebra. Numerical Ability was found to be a significantly better predictor than Space Relations which had the lowest relationship with achievement.

(5) Verbal Reasoning, Numerical Ability and Space Relations showed a significant relationship with achievement of girls in general mathematics. Numerical Ability was found to be a significantly better predictor than Abstract Reasoning which had only a small relationship with achievement.

(6) Multiple correlations between course grades and combination of scores of two tests were found to be higher than correlations of a single test with course grades.

(7) In general, the D.A.T. should be used with caution in predicting grades in general mathematics.

The writer would like to recommend the following:

(1) Continued use of the D.A.T. at Hays High School.

(2) Use of the expectancy tables of this study for counseling with students, parents and teachers.

(3) Use of the expectancy tables of this study to evaluate grading practices in English, algebra and general mathematics.

(4) Use of the expectancy tables as a scatter diagram to find those scores which do not conform to the usual ability patterns.

(5) Further studies should be made to determine the relationships between test scores and grades in additional subject areas.

(6) Further research could be made to determine the value of three subtest scores to predict course grades.

(7) Continued research along the lines of this study to validate the findings of this study.

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